

The Effects of the Flipped Classroom Method and Mobile Phones Use in Physical Education

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Abstract

This pedagogical experiment has been aimed at evaluating the way of preparing Physical Education classes in elementary school. The effects of two methods were compared, one of which is flipped classroom, and the other one is traditional teaching. The flipped classroom method implies prior familiarization of the students with basic information about the content of the next lesson by viewing the video materials that the teacher sends to them via mobile phone. An experiment with two groups was conducted on a sample of 40 elementary school students aged 11 years (± 6 months). The experimental group was formed with 21 participants (11 boys and 10 girls) and the flipped classroom method was implemented with them. The control group consisted of 19 participants (10 boys and 9 girls), and their classes were organized in a traditional manner. The experiment lasted eight weeks, during which 16 lessons lasting 45 minutes each were conducted. Elements of handball were practiced in all classes. The learning outcomes were evaluated on the basis of the participants' grades for six elements: ball catching, passing, dribbling, defensive stance, side shot (chasse) and long jump shot. The effects of the flipped classroom were also evaluated based on the attitudes towards physical education that the participants expressed before and after the experiment, as well as the active workout time in the main part of lesson. The benefits of the flipped classroom in Physical Education, which were explained in previous studies, were confirmed. It has been proved that this method is more effective than traditional teaching. The subjects in the experimental group made significantly more progress in four handball elements. After the treatment, the experimental group had significantly more positive attitudes towards Physical Education than the control group. It was shown that the effects of the flipped classroom depend on the difficulty

of the motor tasks being learned, because in more difficult elements this method did not show an advantage compared to traditional teaching. The greatest effects of the flipped classroom were achieved with tasks of moderate difficulty that are aligned with the developmental level of students' motor skills. The obtained results show that the flipped classroom method can provide a significant contribution to the improvement of Physical Education teaching in elementary school.

Key words: active workout time; attitudes towards Physical Education; elementary school students; handball elements

Introduction

The educational process in schools is constantly adapted to social changes and it evolves rapidly under the influence of new information technologies (IT). In recent years, new didactic tools (digital whiteboards, tablets, applications for smartphones, etc.) have been massively used, offering greater efficiency in the realization of learning outcomes. The use of IT resources creates immediacy, interactivity, flexibility and adaptability to the circumstances in which the teaching process takes place (Gómez-Carrasco et al., 2020; Say and Yildirim, 2020; Tomas et al., 2019). IT is often used as a substitute for traditional education methods. Its application changes the learning process in schools, because students can communicate in real time using their mobile phones or tablets. With the help of IT, they progress in learning, change attitudes, and improve motivation and interests (Dong, 2016; Strayer, 2012).

The massive use of IT has led to the emergence of new educational strategies and the creation of new didactic methods. One of them is the *Flipped Classroom* (FC), which has become widely popular all over the world in recent years (Jong, 2017; Østerlie and Kjelaas, 2019). This pilot study deals with the application of the FC method in Physical Education and aims to valorise its effects. The main means for the application of FC are mobile technologies, which are nowadays massively criticized as the cause of sedentary lifestyles of children and youth. Instead of being criticized, the mobile phone was used in this research as a didactic tool that can contribute to the improvement of *physical education* (PE) in a modern school.

By using FC, the traditional concept of learning in the classroom is reversed so that students already get to know the teaching material at home, before coming to school, and use the time at school to deepen their knowledge through practice, solving problem tasks and interacting with the teacher and other students. In traditional teaching, theoretical information is obtained in class, while practice is mostly carried out outside the classroom. In FC, it is the other way around – part of the theoretical knowledge is acquired independently outside of class (of course, through communication with the teacher), while practice is organised during the class. With this way of learning, students are at the centre of the teaching process and are engaged in activities that require cooperation with the teacher and other students when solving problems. The application of FC encourages the subjective initiative of students and the development

of cognitive abilities, and improves the learning effects by transforming the passive data acceptance into the active acquisition of knowledge (Zhu et al., 2023).

The flipped classroom method is increasingly used in modern schools. The origin of this method is attributed to American chemistry professors Bergmann and Sams (2012). Back in 2007, they tried this approach by recording their lectures and making them available online so that students could view them at any time. Students had to watch that video material as part of their homework, before coming to school. The teachers used the entire school hour only to help the students with the parts that were not completely clear to them, and not for a classical lecture. The FC creates the conditions for achieving the deep (hierarchical) learning, which is considered the highest form of active knowledge (Jdaitawi, 2019). Examining the effects of FC, Zhu et al. (2023) determined that the application of this method in PE teaching can encourage deep learning, which is based on the multi-layered connection of neural units, as opposed to the classical learning algorithm based on lists of commands.

Although the FC is more suitable for application in the so-called theoretical school subjects (Chemistry, Physics, Biology, Literature, etc.), it is increasingly used in PE classes (Say and Yildirim, 2020). There are not many scientific studies that investigated the effects of the FC method in school sports and PE. However, although few, all studies report a positive impact of this method, especially on motor competence, motivation to practice, and students' attitudes towards PE. Felgueras and Delgado (2021) observed better results in students who learned and practiced the elements of handball using FC than their peers who had traditional PE lessons. Ferriz-Valero et al. (2022) reached similar conclusions during an experiment in which they monitored the impact of the FC on the acquisition of knowledge about volleyball elements in elementary school students. The advantages of the FC method over traditional training of sports skills have also been established for table tennis (Zhao & Kang, 2020), as well as korfball (Marqués-Molíás et al. 2019).

The FC method allows the teacher to maximize the use of class time for practical activities, i.e. for active student practice. For this research, previous studies are very significant, as they have proved that the time in the PE lesson is used more efficiently when working according to the FC method (Campos-Gutiérrez et al., 2021; Ferriz-Valero et al., 2021). In the mentioned studies, not only did the active workout time (extent of physical activity) increase, but also the structure of the time teachers use to communicate with students changed. When PE teaching was organized using the FC method, in comparison with traditional classes, teachers devoted much more time to encouraging (motivating) students and correcting mistakes, than they spent on basic explanations, dividing students into groups or organizing space for exercise. The FC method allows students to access different digital sources outside of school and use them in advance as educational content (video clips, video games, simulations, virtual trips, forums, etc.), so that there is more time left for practical activities in class (Campos-Gutiérrez et al, 2021).

Previous studies also indicate the importance of students' attitudes towards PE. Attitudes have been found to be linked to success in school (Bailey, 2006; Portman, 2003; Prochaska, et al., 2003; Subramaniam & Silverman, 2007). Students come to class prepared for different work forms, because they have familiarized themselves with the logic of the motion tasks they are learning or practicing in advance. In this way, a positive attitude towards PE is formed, which contributes to a greater motivation for work. Several studies have proved the high motivational potential of the FC method. Botella et al. (2021) determined that intrinsic motivation significantly increased in students who had PE according to this model. In a study conducted by Hinojo et al. (2020), students included in the FC program received higher grades in PE and achieved better interaction with peers and the teacher. The authors attributed these findings to greater student motivation for work. The authors of several other studies associate faster progress and more effective learning with greater motivation of students to practice when the FC is applied in class (Østerlie & Kjelaas, 2019; Østerlie & Mehus, 2020). Given the importance of attitudes towards PE for motivating students to exercise regularly and willingly, the data on attitudes were also collected in this research.

The flipped classroom is implemented through several steps, such as: planning, searching, selection, preparation and sharing of video materials, grouping of students, division of tasks, outcomes analysis, etc. The preparation of the material is probably the most important phase. The teacher can record themselves or use the existing clips on the Internet. Video materials must be interesting, but not too long, so that students can maintain their attention and easily notice the key information. In this research, video clips related to the elements of handball were used. Handball was chosen because it is very popular in Montenegro, where this research was carried out, and is mandatory content of the PE curriculum in all primary schools.

Methodology

Study design

The study presents a pedagogical experiment with non-probabilistic sampling in which the effects of two ways of organizing Physical Education classes were monitored when initial instruction and practice of basic handball elements were carried out. One experimental treatment involved the application of the flipped classroom method (FC), while the other was implemented through traditional Physical Education classes (TPE). The implementation of the FC method is supported by the use of mobile technologies (primarily mobile phones). The children included in the research had never had systematic training of handball before that, but they gained some experience with the basic elements through ball games as part of PE classes in the previous grade. This is the reason why the assessment of handball skills did not include all the technical elements that are taught in PE classes during the school year, but only the six basic ones that students have elementary prior knowledge of (ball catching, passing, dribbling, defensive stance, side and jump shots).

The research was conducted at “Stefan Mitrov Ljubiša” Elementary School in Budva, where the first author is employed as a Physical Education teacher. The PE teaching in this school is organized three times a week, and each lesson lasts 45 minutes. One of these lessons is intended for the development of general motor abilities, while the remaining two are planned for learning different sports skills (including handball). The experiment was conducted as part of regular lessons in two sixth grade classes taught by the first author. The experiment lasted eight weeks in the period that the school curriculum provides for the implementation of handball content.

Each of the 16 lessons had three parts: 1) introductory-preparatory, 2) main, and 3) final. The first part lasted 8 minutes and included a warm-up. Firstly, a three-minute cyclical activity was carried out (most often running and jump rope), followed by shaping exercises lasting 5 minutes. The main part of the class lasted 32 minutes and included basic learning and practice of handball elements. The content was created in accordance with the instructions from professional literature (Rogulj, 2021). When the students, after the first 4 weeks, sufficiently mastered the basic elements, a two-goal game was organized in each lesson, usually in the form of mini handball (Green, 2024; Hjorth, 2024) which lasted 6-8 minutes. The final part lasted 5 minutes and included stretching and relaxation exercises. The identical content was used in all lessons in both groups. The only difference was in what preceded those lessons. While the students in the control (TPE) group had no previous preparation for the lessons, the students in the experimental (FC) group came with some information about the handball elements obtained in advance.

The teacher sent video material to the students of the experimental group via mobile phone two days before the lesson, using Whatsapp application. These video clips (lasting 4-5 minutes) explained the basic elements of the technique that would be covered in the next lesson and showed the planned exercises. The teacher prepared most of the clips himself, with the help of older students who are members of the school handball team, while some clips were downloaded from YouTube (for example, clips from *Small Handball School* by Hummel <https://www.youtube.com/watch?v=abVjf-3Z0NI>; <https://www.youtube.com/watch?v=s8gd-EE76Qw>). In addition, at the end of the lesson, the students in the experimental group jointly analysed the performance of handball elements by reviewing the recordings on their mobile phones and noting any possible errors.

Whether the students in the experimental group reviewed and to what extent they understood the information from the clips sent in advance was checked by the teacher immediately before the start of each lesson, firstly by reviewing Whatsapp, and then by briefly testing the students' knowledge. In order for students to seriously understand the importance of learning in advance, before each lesson, the teacher checked their knowledge of the information from the video material by randomly asking them several short questions related to the basics of performing handball elements (e.g., “What is the hand position when throwing the ball?”; “What does the correct defensive stance

look like?"; "How is the ball brought into position for throwing after catching?"; "How is a jump shot performed?"; "What is a chasse and when is it performed?", etc.).

The effects of experimental treatments (interventions) were evaluated based on the data on the following variables: (1) motor competence (students' scores obtained for handball elements), (2) students' attitudes towards some aspects of PE (satisfaction, comfort, activity and teacher), and (3) volume of student exercises in class (active workout time). The assessment of the performance quality of handball elements was carried out in accordance with theoretical biomechanical principles that explain rational handball technique (Karišik et al., 2012; Rogulj, 2021). Participants expressed their attitudes towards PE before and after the experiment by filling out a standardized questionnaire. The active workout time was measured in 4 lessons in both groups. All procedures were carried out in accordance with the provisions of the Declaration of Helsinki on working with people (WMA, 2018). The experiment was realized as part of a doctoral dissertation approved by the Senate of the University of Montenegro (decision no. 01-330/10 of July 11, 2024).

Sample

The research was conducted with a group sample. The initial sample included 54 respondents (each comprising 27 students from two classes of the sixth grade of elementary school). The respondents were 11 years old (± 6 months) and students of both gender were equally represented among them. In one class (experimental group), the flipped classroom (FC) was applied, and in the other (control group), the traditional model of Physical Education (TPE) lesson was applied. The main condition for being included in the final sample was that the students in both groups practiced at least 80% of the handball lessons (13 out of 16) implemented during the experimental period. Students who practice handball in a local handball club (four students – two boys and two girls) were also left out of the sample. These student-athletes were not excluded from lessons, but they practiced regularly and supported the teacher when demonstrating certain elements. Based on these criteria (minimum 13 classes of practice and no additional handball training), a total of 40 subjects with complete data were selected in the final sample, of which 21 were in the experimental (FC) and 19 in the control (TPE) group.

Instruments and procedure

Evaluation of handball elements

For the purposes of this research, data (grades) were collected on handball elements that are set by the PE curriculum in elementary school. The following six elements were evaluated: 1) ball catching, 2) passing, 3) dribbling, 4) defensive stance, 5) side shot (chasse), and 6) long jump shot. All elements were evaluated before (pre-test) and after (post-test) the experiment. The correct performance of all elements is described in detail in professional literature (Karišik et al., 2013; Rogulj, 2021).

Handball elements were evaluated by two independent experts (handball coaches) with the assistance of a PE teacher (the first author). The elements performance was evaluated by a numerical grade on a scale from 1 to 5, with five being the highest and one the lowest rating. The final grade was obtained by harmonizing the opinions of the evaluators.

The grades of the handball elements have the following meaning:

Grade 1 – The examinee is unable to successfully perform the given element;

Grade 2 – The examinee performs the given element intermittently and with many errors;

Grade 3 – The examinee performs the given element well, but is unable to repeat it more than three times without making mistakes;

Rating 4 – The examinee performs the given element in a coordinated manner when no one disturbs him, but makes mistakes when he speeds up the movement or when he performs the element in the game;

Grade 5 – The examinee performs the given element in a coordinated manner at higher speeds, as well as during the game, with minimal technical errors.

The defensive stance was the only element performed without the ball, so a specific approach was applied to its evaluation. The evaluators primarily observed the ability of the students to maintain a given knee joint angle in exercises performed in place and in motion. They also paid significant attention to the effectiveness of the defence while playing mini handball. They carefully discussed each assessment, and formed it by consensus.

Assessment of attitudes towards Physical Education

The PEAS instrument (**Physical Education Attitude Scale**), which was designed and standardized by Orlić et al. (2017) on the school population, was used to assess attitudes towards PE. The authors and 50 master's students of the Faculty of Sports and Physical Education generated 124 initial items during professional practice. After eliminating duplicate and ambiguous items, a factor analysis was conducted and only 43 items were retained in the final version of the questionnaire. Four stable components were extracted from these items, which explain 48% of the total variance, and were named as follows: (1) Satisfaction (12 items), (2) Comfort (12 items), (3) Activity (11 items), and (4) Teacher (8 items). A five-level Likert technique was used to indicate the attitude towards each of the 43 statements, while giving the answer as quickly as possible. The responses were formulated as follows: 1) Strongly disagree, 2) Disagree, 3) Undecided, 4) Agree, and 5) Strongly agree. The response most favourable to PA received a score of five, while the least favourable response received a score of one. Some items were formulated positively and some negatively, so before the final calculation, it was necessary to perform an inversion (recoding) of negative statements. The recoding procedure was as follows: 1→5, 2→4, 4→2 and 5→1. The final score for each of the four PEAS components is the average calculated from the corresponding items.

Although this instrument was standardized on a population of 13-year-old students, it was applied here to slightly younger children. This is one of the limitations of the study that the authors were aware of, but wanted to see how the PEAS “works” with 11-year-olds. In some future research, it would be good to check the metrics of this instrument, but on a much larger sample of fifth- and sixth-grade students.

The active workout time measuring in Physical Education class

The data of the active workout in the PE class was registered using the SOFIT instrument (System for Observing Fitness Instruction Time) constructed by McKenzie et al. (1991). It was often used in previous studies (McKenzie & Smith, 2017; McNamee & van der Mars, 2005; Powel et al., 2016; Smith et al., 2019). It was originally designed as a diagnostic instrument intended for PE teachers to control class workload, and was later modified and adapted for research purposes. The latest version of the instrument described in the manual available on the Internet (McKenzie, 2015) was used in the current study. Active time was measured only in the main part of the lesson, and it was carried out by three students who did not perform exercises. Each of them used a mobile phone to record one subject during the main part of the class, then downloaded the relevant data and entered it into the observation sheet. The active students did not know who was recording them. Active time was measured during four lessons randomly chosen by the teacher. For the final time calculation, the data of all students were used and the average was derived from them. These averages were treated as indicators of the whole group engagement during the Physical Education lesson.

The observation sheet for data entry foresees 8 four-minute segments divided into several intervals of 20 seconds (3 intervals per minute). During the 4 minutes of observation, data were recorded for 12 intervals, that is, a total of 96 intervals for the entire main part of the lesson, which lasts 32 minutes. Special codes were used to enter data on activities with different energy consumption: code 1 indicates lying down, code 2 sitting, code 3 standing, code 4 walking and code 5 any movement in which the student consumes more energy than for average walking (e.g., running, jumping, passing and catching, dribbling, goal shooting, etc.). Data entry was carried out by circling the appropriate code (1, 2, 3, 4 or 5), which made recording easier and faster. The active workout time is expressed in two ways - as a relative value (percentages) and as an absolute time (minutes).

Statistical analyses

Basic descriptive parameters were calculated for each variable – the arithmetic mean (Mean) and standard deviation (SD).

Mixed between-within subjects ANOVA (Tabachnick & Fidell, 2013) was used to evaluate the effects of the experimental treatment and to check the homogeneity of the groups before the start of the experiment. Two factors (two independent variables) were combined: the time (within-group variability) and the specificity of two groups (between-group variability). A mixed 2 x 2 design was applied for the comparison

of two groups' data from different time points (pre-test and post-test). The actual influence of the independent variables (treatment and group), both joint (interaction of factors) and separate, was estimated using Partial Eta Squared (η^2), based on the criteria proposed by Cohen (1988). This procedure was applied to the ratings of six handball elements and to the data on the respondents' attitudes towards PE obtained before and after the experiment.

Independent Sample t-test was applied to evaluate the significance of the differences between the arithmetic means obtained in the experimental and control groups for the active workout time in the PE lesson. Using Levene's test (Pallant, 2020), the assumption of homogeneity of variance was checked before interpreting the results of both inferential procedures (ANOVA and T-test).

All statistical analyses were performed by using IBM SPSS v.21 software package (License Stats Prem: 761b17dcfd1bf20da576 by Hearne software), and statistical significance was set at 0.05 ($p < 0.05$).

Results

Descriptive data on the handball elements that were assessed before and after the experiment are presented in Table 1, and they show that the groups were very homogeneous in terms of initial handball skills before the treatment. The results of the Mixed ANOVA reveal that only the treatment had a significant influence on the changes in average grades for all elements, while the influence of the groups was non-existent. The factor interaction impact was determined at four elements – ball catching, passing, side shot (chasse), and long jump shot (Table 2). In the other two handball elements, dribbling and defensive stance, there was no significant influence of the factor interaction, which means that the groups did not differ significantly in these elements at the end of the experiment. Practically, both groups significantly improved dribbling and defensive stance, and both treatments (FC and TPE) were approximately equally effective. These findings show that both groups significantly improved all elements under the influence of exercise, but that the changes in the quality of catching, passing and goal shooting were significantly greater in the experimental (FC) group, in which the flipped classroom method was applied (Figure 1).

Table 1
Average scores of basic handball elements before and after the experiment

Element	Group	N	Pre-test		Post-test	
			Mean	SD	Mean	SD
Ball Catching	FC	21	2.19	0.602	3.52	0.512
	TPE	19	2.11	0.567	3.05	0.524
Passing	FC	21	2.29	0.561	3.76	0.700
	TPE	19	2.26	0.653	3.16	0.602
Dribbling	FC	21	1.86	0.655	2.90	0.700
	TPE	19	1.89	0.567	2.79	0.535

Element	Group	N	Pre-test		Post-test	
			Mean	SD	Mean	SD
	TPE	19	2.16	0.602	2.84	0.501
Side shot (chasse)	FC	21	1.52	0.512	3.62	0.669
	TPE	19	1.58	0.507	3.11	0.567
Long jump shot	FC	21	1.62	0.498	3.81	0.680
	TPE	19	1.63	0.496	3.21	0.631

FC = Flipped Classroom; TPE = Traditional Physical Education; N = Participants number

Table 2
The Mixed ANOVA results related to the basic handball elements from Table 1

Impact	Wilks' Lambda	F	p	η^2	Observed power
<i>Ball Catching</i>					
Factor interaction	0.887	4.862	0.034	0.113	0.575
Treatment	0.183	169.766	<0.001	0.817	1
Group	/	3.371	0.074	0.081	0.432
<i>Passing</i>					
Factor interaction	0.728	14.196	0.001	0.272	0.956
Treatment	0.139	236.027	<0.001	0.861	1
Group	/	2.885	0.098	0.071	0.381
<i>Dribbling</i>					
Factor interaction	0.974	1.013	0.320	0.026	0.166
Treatment	0.189	163.588	<0.001	0.811	1
Group	/	0.046	0.832	0.001	0.055
<i>Defensive stance</i>					
Factor interaction	0.955	1.810	0.186	0.045	0.259
Treatment	0.360	67.425	<0.001	0.640	1
Group	/	0.023	0.880	0.001	0.053
<i>Side shot (chasse)</i>					
Factor interaction	0.795	9.779	0.003	0.205	0.862
Treatment	0.088	396.249	<0.001	0.912	1
Group	/	2.174	0.149	0.054	0.301
<i>Long jump shot</i>					
Factor interaction	0.827	7.933	0.008	0.173	0.784
Treatment	0.112	301.391	<0.001	0.888	1
Group	/	3.872	0.056	0.092	0.483

Descriptive data on the attitudes towards PE expressed by the respondents before and after the experiment are shown in Table 3 and illustrated by Figure 2. They show that before the treatment application, the groups were very homogeneous in relation

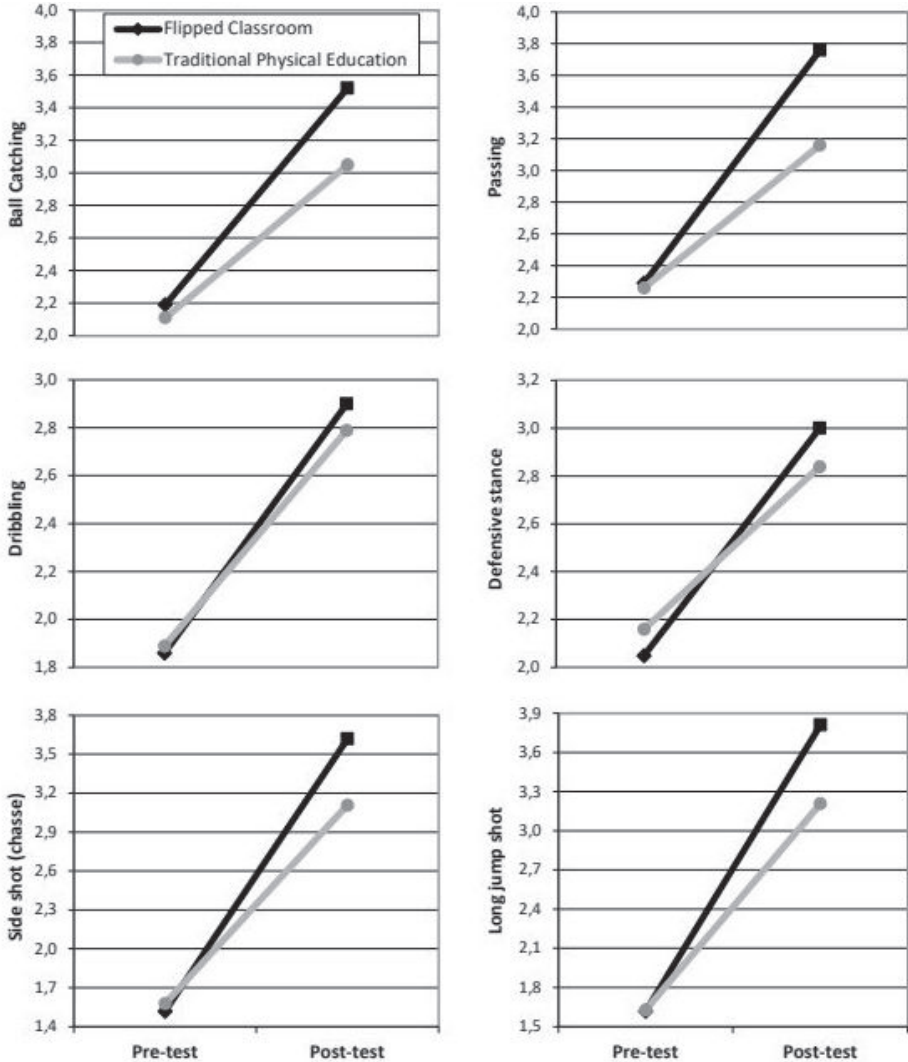


Figure 1. Average scores of basic handball elements before and after the experiment

to all four subscales (satisfaction, comfort, activity and teacher). The results of the Mixed ANOVA (Table 4) reveal that both the interaction of the factors and the separate influence of the treatment were statistically significant for all four subscales, while the separate influence of the groups was completely absent. These findings show that kinesiology interventions in both groups led to significant positive changes in attitudes towards PE, but they were more pronounced in the experimental (FC) group.

Table 3
Average scalar values of attitudes toward Physical Education before and after the experiment

Element	Group	N	Pre-test		Post-test	
			Mean	SD	Mean	SD
Satisfaction	FC	21	3.57	0.731	3.89	0.549
	TPE	19	3.58	0.657	3.66	0.601
Comfort	FC	21	3.83	0.775	4.15	0.550
	TPE	19	3.87	0.754	3.95	0.714
Activity	FC	21	3.47	0.839	3.81	0.635
	TPE	19	3.40	0.821	3.50	0.769
Teacher	FC	21	3.82	0.337	4.16	0.276
	TPE	19	3.84	0.354	3.88	0.324

FC = Flipped Classroom; TPE = Traditional Physical Education; N = Participants number

Table 4
The Mixed ANOVA results related to the attitudes toward Physical Education from Table 4

Impact	Wilks' Lambda	F	p	η^2	Observed power
<i>Satisfaction</i>					
Factor interaction	0.723	14.523	<0.001	0.277	0.960
Treatment	0.483	40.658	<0.001	0.517	1
Group	/	0.322	0.574	0.008	0.086
<i>Comfort</i>					
Factor interaction	0.697	16.514	<0.001	0.303	0.977
Treatment	0.461	44.452	<0.001	0.539	1
Group	/	0.133	0.718	0.003	0.065
<i>Activity</i>					
Factor interaction	0.749	12.719	0.001	0.251	0.935
Treatment	0.486	40.165	<0.001	0.514	1
Group	/	0.614	0.438	0.016	0.119
<i>Teacher</i>					
Factor interaction	0.450	46.497	<0.001	0.550	1
Treatment	0.315	82.803	<0.001	0.685	1
Group	/	1.670	0.204	0.042	0.243

The data obtained for the active workout time measured in the main part of the class are presented in Table 5 and illustrated by Figure 3. The results reveal that the students in the experimental (FC) group spent significantly more time in the higher intensity activities, and they stood and walked significantly less. The groups did not differ significantly only in sitting.

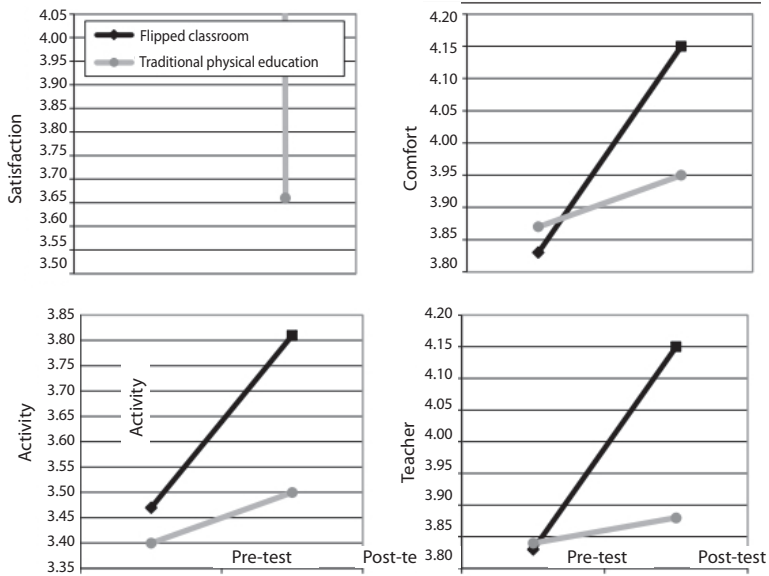


Figure 2. Average scalar values of attitudes toward Physical Education before and after the experiment

Table 5

Average of active workout time in the Physical Education (PE) class for different groups

Activities	Flipped Classroom		Traditional PE		T-test	
	Time		Time		t	p
	Minutes	%	Minutes	%		
Sitting	0.75	2.34	0.53	1.66	1.181	0.247
Standing	6.09	19.04	8.00	25.00	-10.075	<0.001
Walking	9.12	28.52	9.81	30.66	-3.258	0.003
More intensive	16.03	50.10	13.66	42.68	11.161	<0.001

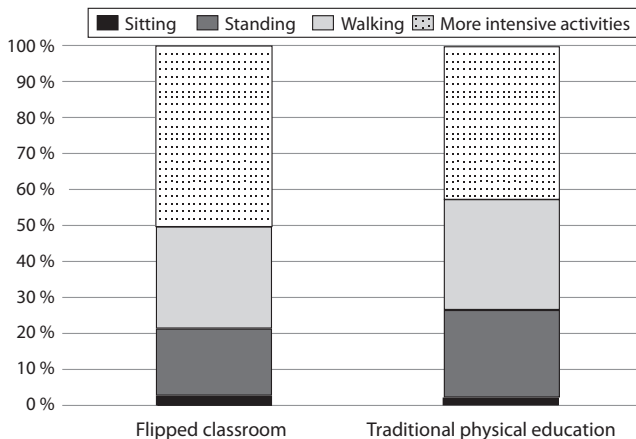


Figure 3. The percentage of different intensity activities in the Physical Education class

Discussion

In this research, the effects of a modern organization model of Physical Education (PE) classes, which has been increasingly applied in recent years in schools around the world, have been analysed. It includes the flipped classroom (FC) that involves sharing basic theoretical and visual information about the content of the upcoming PE class in advance and using mobile technologies (primarily mobile phones). This method significantly changes the traditional way of lesson preparation for both teachers and students. In the traditional PE teaching (TPE), the teacher spends a lot of time giving basic information about the activities covered in the class, while sharing information before the class creates more time for practical work (learning and exercise). The results of several previous studies prove the advantages of FC over TPE during the implementation of different teaching contents. The positive effects of the FC method are mostly manifested through the improvement of motor competence, motivation for exercise and attitudes towards PE (Østerlie & Kjelaas, 2019; Østerlie & Mehus, 2020). Greater motor progress was found for handball (Felgueras & Delgado, 2021), volleyball (Feriz-Valero et al., 2022), table tennis (Zhao & Kang, 2020), and korfbal (Markues-Molias et al. 2019). In this research, the FC impact on the handball elements which 11-year-old children learn and practice was monitored. Handball was chosen because it is included in the curriculum of regular PE classes in elementary schools and is implemented with sixth-grade students whose teacher was the first author.

The results of this confirmed all the findings of previous studies. It has been shown that handball is a suitable activity for the application of the FC method. The experimental group had significantly greater progress than the control group after the interventions in four of the six handball elements monitored. The benefits of this method of preparing the PE lesson were absent in the elements with the lowest grades, which were obviously more difficult for the students – dribbling and defensive stance moving. This finding leads to the conclusion that the effectiveness of the FC method depends on the difficulty of the motor task being learned. The FC method was the most effective in easier motor tasks, i.e. those for which the students got the best grades. These are elements related to basic handball skills, the complexity of which is coordinated with the developmental level and motor skills of children at this age.

It remains an open question why the respondents in both groups received lower grades for the dribbling and the defensive stance? Is the dribbling, especially in movement, so demanding for sixth-graders that even after two months of classes, their average grade is less than three? The absence of higher average grades is probably a consequence of the fact that this element is used the least in the handball game and that the least amount of time was spent on it in class. This shows that, despite clear explanations and visual instructions that students receive in advance, direct practice (physical activity) is essential for motor learning. A flipped classroom in itself does not guarantee success if there are no practical activities (training, trying, exercise, etc.). On

the other hand, much time was spent and more exercises were organized to practice moving in a defensive stance, but the average score in the control group remained less than three even after the treatment, and it was exactly three in the experimental group. One of the possible explanations is the fact that the quality of movement in a defensive stance depends a lot on the strength of the leg extensor muscles (Karišik et al., 2013), which is probably insufficiently developed in subjects at this age. In any case, the effectiveness and progress of the defensive stance was more difficult to explain compared to the others handball elements with the ball. It was observed that, despite good performance of the defensive stance in the exercises used for learning, some subjects played defence poorly in mini-handball. And vice versa - some subjects were very successful in defence during the mini-handball game, but according to the evaluators, they had a weaker technical performance. It seems that the quality of defence in handball, except defensive stance technique, is influenced by many more factors that were not evaluated in this study (e.g., strength, speed, coordination, agility, tactical skills, etc.).

The FC method gave the best results for the elements that are used the most in the handball game and on which the most time was spent during the lessons – passing, catching and shooting. Their mean scores in both groups were significantly higher on the post-test than on the pre-test, but with much greater changes in the experimental group. Their complexity is clearly in line with the current motor development of the sixth-graders and these elements probably do not depend much on the strength of the current musculature. This assumption is supported by the findings of previous studies, which proved that technique, not strength, is crucial for the quality of throwing a handball (Arias, 2012; Manchado et al., 2017; Perić et al., 2015; Rivilla-Garsia et al., 2011).

The longer active workout time in the lessons of the experimental group probably influenced the more efficient development of motor competence. Their active time in the main part of the lesson was about 7.5% longer than that of the students in the control group. At first glance, this is not much, especially when it is expressed in minutes, but it is still statistically significant. Students who received didactic video materials before lessons and used mobile phones to familiarize themselves in advance with basic information about the handball elements were, on average, two and a half minutes more active than students who had traditional PE classes. The FC method allowed the experimental group to reach 50% of the active workout time in class, which was recommended in previous studies as the necessary minimum for fulfilling the basic aims of the school PE (Hallal et al., 2012; Hollis et al., 2016; WHO, 2014). On the other hand, the average active time of the control group did not even reach 43%. The greater activity of the experimental group is also revealed by the data on the time spent standing, for which a statistically significant difference was also determined to the detriment of the control group. Students who had no theoretical preparation before the class, on average, spent 1/4 of the main lesson part standing, most likely listening to the teacher's explanations about the correct execution of an

element or about correcting mistakes. These data confirm the findings of previous studies (Campos-Gutiérrez et al., 2021; Ferriz-Valero et al., 2021; Zhu et al., 2023) which also proved that using theoretical and visual information obtained in advance through the FC method can extend active class time. These data confirm the findings of previous studies (Campos-Gutiérrez et al., 2021; Ferriz-Valero et al., 2021; Zhu et al., 2023) which also proved that theoretical and visual information obtained in advance can influence the increase of active workout time. In this research, significantly longer active time was registered in PE lesson than in previous studies in which ball games (basketball, volleyball and handball) were also used. Marković et al. (2012) report that the average utilization of those lessons is 41%, and Kostić et al. (2020) 42%, stating that it mostly depends on the lesson preparation.

The results of this research unequivocally indicate a significant impact of the FC method on improving students' attitudes towards PE. The respondents in both groups expressed a moderately positive attitude towards all aspects of PE even before the experimental treatment. These average values increased further after the experiment, but statistically significant changes were registered only in the group that worked according to the flipped classroom method. The attitudes of the respondents in different groups did not differ significantly before the intervention, while eight weeks later the respondents in the experimental group had significantly higher average values of all subscales (satisfaction, comfort, activity and teacher). At the end of the experiment, the ratings for ease and the teacher were even higher than 4. These results prove that the achieved effects can be attributed to the experimental method of teaching preparation. The flipped classroom, by all accounts, provided students with more time for active practice, reduced time spent in passive positions (standing and walking), and enriched communication between teachers and students. These observations are consistent with the results of previous studies that also examined teacher activity in class (Hinojo et al., 2020; Østerlie & Kjelaas, 2019; Østerlie & Mehus, 2020) and students' attitudes toward PE (Bailey, 2006; Portman, 2003; Prochaska et al., 2003; Subramaniam & Silverman, 2007). All the mentioned studies proved a positive connection between the flipped classroom method on the one hand, and teacher engagement and student attitudes on the other.

In addition to obtaining information about handball elements, mobile phones were also used to measure the active workout time in class. This was the task of the students who were present in class, but did not practice. Later, based on the recorded material, they filled out the SOFIT observation sheet and together with their schoolmates analysed the performance of handball elements. In this way, inactive students who are completely passive and usually get bored in class, become active participants in the teaching process, increasing their interests and acquiring at least theoretical knowledge about certain sports content. Deeper student-teacher and student-student communication, through joint analysis of recorded activities, brings the teaching process closer to what is called deep learning in modern pedagogy and represents the highest form of active knowledge (Fallah et al., 2022; Ferriz-Valero et al., 2022). The FC method

encouraged deep learning, considering that the students received information about handball elements in layers and mentally processed them not only while practicing in class, but also before and after that. They first tried to understand the basic theoretical (biomechanical) messages about the motor content that awaited them on their own, then they practically performed it in class with their classmates, and they continued with the analyses even after class through video material viewing and discussion with other students and the teacher. This achieved multi-layered communication between neural units and expanded the context in which the educational material was cognitively processed.

In addition to students, the flipped classroom also brings benefits to teachers, bringing them closer to the TPACK model (*Technological Pedagogical Content Knowledge*), which is intensively applied in modern school, instructing the PE teacher to master the necessary knowledge and skills to successfully integrate mobile technology into the teaching process. This model is most often represented by a Venn diagram, the section of which represents the minimum sum of competencies of a modern teacher (Archambault & Barnett, 2010). These are competences in the field of technology, specific profession (in this case kinesiology), pedagogical-didactic and methodical competences, and the ability to apply mixed models (e.g., flipped classroom). The experiences of researchers show that a more digitally competent teacher is more ready to apply modern didactic methods, because his greater competences increase the motivation to introduce new teaching models (Balanskat, 2013; Pegrum et al., 2013). Specialization in the use of digital tools implies building a teaching environment focused on the aims of physical education, getting to know complementary areas and applying a holistic approach to pedagogical tasks.

Although empirical data have shown that the FC method can bring a number of benefits to modern PE teaching, it is important to point out several limitations of this study. They are primarily related to non-probability sampling and the small number of respondents included in the analyses. The control group sample was used for the experiment and data collection, i.e., only two classes of one school. Although an effort was made to ensure the independence of the subjects of the two groups, it was difficult for the students who made up the control group to hide the fact that their colleagues from the same school and the same shift, who made up the experimental group, were participating in scientific research. This knowledge could cause a placebo effect in the subjects of the control group and indirectly influence changes in many variables, regardless of the objective (in)action of the treatment.

Another limitation that suggests caution when generalizing the obtained results is related to the choice of the teaching content. In this research, only elements of handball were applied, so it would be useful in future research to check how the flipped classroom works in other sports (athletics, gymnastics, swimming, basketball, etc.). In addition, it would be good to measure some motor abilities of students and treat them as statistical covariates that can indirectly affect the speed and quality of motor

learning. For example, when moving in a defensive stance, no significant differences were obtained between subjects of the experimental and control group, so the insufficient strength of the leg extensor muscles was cited as a hypothetical explanation.

Conclusion

An experiment was conducted with two classes of the sixth grade of elementary school in which the effects of two methods of preparing Physical Education lessons were compared. The students learned and practiced the elements of handball. The first method was flipped classroom, while the second implied the traditional implementation of Physical Education lessons. As part of the flipped classroom, video material with theoretical and visual information about the content covered in Physical Education lesson was distributed to the students in advance via mobile phones. The experiment lasted two months (8 weeks) and 16 lessons, each lasting 45 minutes, were implemented. In addition to sports achievement, which was evaluated on the basis of grades for the performance of handball elements, students' attitudes towards Physical Education were assessed and the active workout time in the main part of the lesson was measured.

The obtained results confirmed the value of the flipped classroom method established in previous studies. It has been proved that this way of work is more effective than traditional teaching. The subjects in the experimental group achieved better grades in five of six handball elements (passing, catching and goal shooting). Subjects in both groups expressed a moderately positive attitude towards Physical Education before the experiment and did not differ significantly, while after the treatment, the subjects in the experimental group had significantly more positive attitudes than the subjects in the control group. The experimental group had a longer active workout time in the main part of the lesson. In this group, a level of 50% student engagement was reached, which is more than the time measured in previously conducted research in which sports games with a ball were also used. The obtained results show that the flipped classroom method can provide a significant contribution to the improvement of Physical Education teaching in primary schools.

It has been shown that the effects of the flipped classroom method depend on the complexity of the motor tasks that are handled in the class. In the more coordination-difficult element (dribbling), this method did not result in a didactic advantage over traditional teaching. The greatest effects of the flipped classroom were achieved with tasks of moderate difficulty that are aligned with the developmental level of the subjects' motor skills (in this study, these are all types of passing and catching, as well as all types of shooting). If the effectiveness of the flipped classroom method in the field of motor skills had certain limits, its strong influence on the attitudes towards Physical Education was unquestionable. It has been proved that the flipped classroom significantly contributes to more efficient use of time in Physical Education lessons, and that the controlled use of mobile phones benefits the teaching process and improves the communication between all its participants.

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Učinci metode obrnute učionice i korištenja mobitela u nastavi tjelesnoga odgoja

Sažetak

Ovaj pedagoški eksperiment imao je za cilj vrednovanje načina pripremanja nastave tjelesnoga odgoja u osnovnoj školi. Uspoređeni su učinci dviju metoda, od kojih je jedna obrnuta učionica, a druga tradicionalna nastava. Obrnuta učionica podrazumijeva prethodno upoznavanje učenika s osnovnim informacijama o sadržaju sljedeće lekcije gledanjem videomaterijala koje im nastavnik šalje putem mobitela. Na uzorku od 40 učenika osnovne škole u dobi od 11 godina (± 6 mjeseci) proveden je eksperiment s dvije skupine. Eksperimentalnu je činio 21 ispitanik (11 dječaka i 10 djevojčica) i s njima je provedena obrnuta učionica. Kontrolnu skupinu činilo je 19 ispitanika (10 dječaka i 9 djevojčica), a nastava im je bila organizirana na tradicionalan način. Eksperiment je trajao osam tjedana tijekom kojih je provedeno 16 sati po 45 minuta. Na svim satima uvježbavani su elementi rukometa. Ishodi učenja vrednovani su na temelju ocjena koje su sudionici dobili za šest elemenata: hvatanje, dodavanje, vođenje lopte, obrambeni stav, bočni šut (šase) i skok šut u dalj. Učinci obrnute učionice procijenjeni su i na temelju stavova prema tjelesnom odgoju koje su ispitanici izrazili prije i nakon eksperimenta, kao i vremena aktivnoga vježbanja u glavnom dijelu sata. Potvrđene su prednosti obrnute učionice u nastavi tjelesnoga odgoja koji su objašnjeni u prijašnjim studijama. Dokazano je da je ova metoda učinkovitija od tradicionalne nastave. Ispitanici eksperimentalne skupine značajno više su napredovali u četirima rukometnim elementima. Nakon primjene metode obrnute učionice eksperimentalna skupina imala je signifikantno pozitivnije stavove prema tjelesnom odgoju od kontrolne. U eksperimentalnoj skupini izmjereno je duže aktivno vrijeme vježbanja u glavnom dijelu sata. Pokazalo se da učinci obrnute učionice ovise o težini motoričkih zadataka koji se uče jer u težim elementima ova metoda nije pokazala prednost u odnosu na tradicionalnu nastavu. Najveći učinci obrnute učionice postignuti su u zadacima koji su usklađeni s razvojnom razinom motoričkih sposobnosti učenika. Rezultati pokazuju da metoda obrnute učionice može dati značajan doprinos unaprjeđenju nastave tjelesnoga odgoja u osnovnoj školi.

Ključne riječi: elementi rukometa; stavovi prema tjelesnom odgoju; učenici osnovnih škola; vrijeme aktivnoga vježbanja

Uvod

Obrazovni proces u školi kontinuirano se prilagođava društvenim promjenama i ubrzano razvija pod utjecajem novih informacijskih tehnologija (IT). Posljednjih godina masovno se koriste novi didaktički alati (digitalne ploče, tableti, aplikacije za pametne telefone i sl.) koji nude veću učinkovitost u ostvarivanju ishoda učenja. Korištenje informatičkih resursa stvara neposrednost, interaktivnost, fleksibilnost i prilagodljivost okolnostima u kojima se odvija nastavni proces (Gómez-Carrasco i sur., 2020; Say i Yildirim, 2020; Tomas i sur., 2019). IT se često koristi kao zamjena za tradicionalne obrazovne metode. Njihova primjena mijenja proces učenja u školama jer učenici mogu komunicirati u stvarnom vremenu pomoću mobitela ili tableta. Uz pomoć IT-a napreduju u učenju, mijenjaju stavove, poboljšavaju motivaciju i interese (Dong, 2016; Strayer, 2012).

Masovna upotreba IT-a dovela je do pojave novih obrazovnih strategija i kreiranja novih didaktičkih metoda. Jedna od njih je *obrnuta učionica* (OU) koja posljednjih godina postaje sve popularniji u cijelom svijetu (Jong, 2017; Østerlie i Kjelaas, 2019). Ova pokusna studija bavi se primjenom OU metode u tjelesnom odgoju i cilj joj je valorizirati njezine učinke. Glavno sredstvo za primjenu OU-a su mobilne tehnologije, koje su danas najviše kritizirane kao uzrok sedentarnoga načina života djece i mladih. Umjesto da bude kritiziran, mobitel je u ovom istraživanju korišten kao didaktički alat koji može pridonijeti unaprjeđenju *tjelesnoga odgoja* (TO) u suvremenoj školi.

Primjenom OU-a preokreće se tradicionalni koncept učenja u razredu tako da učenici već kod kuće, prije dolaska u školu, upoznaju nastavno gradivo, a vrijeme u školi koriste za produblivanje znanja vježbanjem, rješavanjem problemskih zadataka i interakcijom s nastavnikom i drugim učenicima. U klasičnoj nastavi teorijske se informacije stječu u razredu, dok se vježbanje uglavnom odvija izvan učionice. U OU-u je obrnuto – dio teorijskoga znanja stječe se samostalno izvan učionice (naravno u komunikaciji s nastavnikom), dok se uvježbavanje odvija tijekom nastave. Ovakvim načinom učenja učenici su u središtu nastavnoga procesa i uključeni su u aktivnosti koje zahtijevaju suradnju s nastavnikom i drugim učenicima pri rješavanju problema. Primjena OU-a potiče subjektivnu inicijativu učenika i razvoj kognitivnih sposobnosti te poboljšava učinke učenja transformirajući pasivno prihvaćanje podataka u aktivno stjecanje znanja (Zhu i sur., 2023).

Obrnuta učionica sve se više koristi u modernim školama. Podrijetlo ove metode pripisuje se američkim profesorima kemije J. Bergmanu i A. Samsu (Bergmann i Sams, 2012). Oni su još 2007. godine isprobali ovaj pristup snimajući svoja predavanja i stavljajući ih na internet kako bi ih studenti mogli pogledati u svakom trenutku. Studenti su dobili zadaću pogledati taj videomaterijal prije dolaska u školu. Profesori su cijeli školski sat iskoristili samo za pomoć učenicima u dijelovima koji im nisu bili posve jasni, a ne za klasično predavanje. OU stvara uvjete za postizanje dubokoga (hijerarhijskoga) učenja (engl. *Deep Learning*), koje se smatra najvišim oblikom aktivnoga znanja. Ispitujući učinke OU-a, Zhu i sur. (2023) utvrdili su da primjena ove metode u nastavi TO-a

može potaknuti duboko učenje koje se temelji na višeslojnoj povezanosti neuronskih jedinica, za razliku od klasičnoga algoritma učenja temeljenoga na listama naredbi.

Iako je OU prikladniji za primjenu u tzv. teorijskim školskim predmetima (kemija, fizika, biologija, književnost itd.), sve se više koristi u nastavi TO-a (Say i Yildirim, 2020). Malo je znanstvenih studija koje su istraživale učinke OU metode u školskom sportu i TO-u. No, iako malobrojne, sve studije pokazuju pozitivan utjecaj ove metode, posebice na motoričke kompetencije, motivaciju za vježbanje i stavove učenika prema TO-u. Felgueras i Delgado (2021) uočili su bolje rezultate onih učenika koji su učili i uvježbavali elemente rukometa pomoću metode OU-a od svojih vršnjaka koji su imali tradicionalnu nastavu TO-a. Do sličnih zaključaka došli su i Ferriz-Valero i sur. (2022) tijekom eksperimenta u kojem su pratili utjecaj OU-a na usvajanje znanja o elementima odbojke učenika osnovne škole. Prednosti PU metode u odnosu na tradicionalnu obuku sportskih vještina utvrđene su i za stolni tenis (Zhao i Kang, 2020), kao i za *korfball* (Marqués-Molíás i sur. 2019).

Metoda OU-a omogućuje nastavniku da vrijeme nastavnoga sata maksimalno iskoristi za praktične aktivnosti, tj. za aktivno vježbanje učenika. Za ovo istraživanje vrlo su značajne prethodne studije u kojima je dokazano da se vrijeme na satu TO-a koristi učinkovitije kada se radi po metodi OU-a (Campos-Gutiérrez i sur., 2021; Ferriz-Valero i sur., 2021). U navedenim istraživanjima ne samo da se povećalo vrijeme aktivnoga vježbanja (opseg tjelesne aktivnosti), već se promijenila i struktura vremena koje nastavnici koriste za komunikaciju s učenicima. Kada je nastava TO-a organizirana po OU metodi, nastavnici su, u odnosu na klasičnu nastavu, puno više vremena posvetili poticanju (motiviranju) učenika i ispravljanju pogrešaka, nego što su ga trošili na osnovna objašnjenja, podjelu učenika u grupe ili organiziranje prostora za vježbanje. Model OU-a omogućava učenicima da izvan škole pristupe različitim digitalnim izvorima i unaprijed ih koriste kao obrazovne sadržaje (videoisječci, videoigre, simulacije, virtualni izleti, forumi i dr.), kako bi im na satu ostalo više vremena za praktične aktivnosti (Campos-Gutiérrez i sur., 2021).

Prijašnja istraživanja također ukazuju na važnost stavova učenika prema TO-u. Utvrđeno je da su stavovi povezani s uspjehom u školi (Bailey, 2006; Portman, 2003; Prochaska i sur., 2003; Subramaniam i Silverman, 2007). Učenici dolaze na nastavu pripremljeni za različite oblike rada jer su se unaprijed upoznali s logikom kretnih zadataka koje uče ili uvježbavaju. Na taj se način formira pozitivan stav prema TO-u što pridonosi većoj motiviranosti za rad. Nekoliko je studija dokazalo visok motivacijski potencijal PU metode. Botella i sur. (2021) utvrdili su da se intrinzična motivacija značajno povećala kod učenika koji su imali TO po ovom modelu. U studiji koju su proveli Hinojo i sur. (2020) učenici uključeni u program OU-a dobili su više ocjene iz TO-a i ostvarili bolju interakciju s vršnjacima i nastavnikom. Autori su te nalaze pripisali većoj motiviranosti učenika za rad. Autori još nekoliko studija povezuju brži napredak i učinkovitije učenje s većom motiviranošću učenika za vježbanje kada je na satu primijenjena OU (Østerlie i Kjelaas, 2019; Østerlie i Mehus, 2020). S obzirom na

važnost stavova prema TO-u za motiviranje učenika da redovito i s voljom vježbaju, u ovom istraživanju prikupljeni su podatci i o stavovima.

Obrnuta učionica provodi se u nekoliko koraka, kao što su: planiranje, pretraživanje, odabir, priprema i dijeljenje videomaterijala, grupiranje učenika, podjela zadataka, analiza ishoda itd. Priprema materijala vjerojatno je najvažnija faza. Nastavnik može snimiti sâm ili iskoristiti postojeće isječke na internetu. Videomaterijali moraju biti zanimljivi, ne predugi, kako bi učenici mogli zadržati pažnju i lako uočiti ključne informacije. U ovom istraživanju korišteni su videoisječci vezani uz elemente rukometa. Rukomet je odabran jer je vrlo popularan u Crnoj Gori, gdje je ovo istraživanje provedeno, te je obavezan sadržaj nastavnoga plana i programa TO-a u svim osnovnim školama.

Metodologija

Postupci istraživanja

Studija predstavlja pedagoški eksperiment s neprobabilističkim uzorkovanjem u kojem su praćeni učinci dvaju načina organizacije nastave tjelesnoga odgoja pri provođenju početne obuke i uvježbavanja elemenata rukometne igre. Jedan eksperimentalni postupak uključivao je primjenu metode obrnute učionice (OU), dok je drugi implementiran u tradicionalnu nastavu tjelesnoga odgoja (TTO). Implementacija PU metode podržana je korištenjem mobilnih tehnologija (prije svega mobitela). Djeca obuhvaćena istraživanjem nikada ranije nisu imala sustavan trening rukometa, ali su određena iskustva s osnovnim elementima stekla u igrama loptom u sklopu nastave TO-a u prethodnom nižem razredu. To je razlog zašto procjena rukometnih vještina nije uključivala sve tehničke elemente koji se uče na nastavi TO-a tijekom školske godine, već samo šest osnovnih o kojima učenici imaju elementarna predznanja (hvatanje, dodavanje, vođenje lopte, obrambeni stav, bočni i skok šut).

Istraživanje je provedeno u Osnovnoj školi „Stefan Mitrov Ljubiša“ u Budvi, gdje je prvi autor zaposlen kao profesor tjelesnoga odgoja. Nastava TO-a u ovoj školi organizirana je triput tjedno, a svaki sat traje 45 minuta. Od ta tri sata, jedan je namijenjen razvoju općih motoričkih sposobnosti, dok su preostala dva planirana za učenje različitih sportskih vještina (između ostaloga i rukometa). Eksperiment je proveden u sklopu redovne nastave u dvama razrednim odjelima šestoga razreda kojima predaje prvi autor. Eksperiment je trajao osam tjedana u razdoblju koje je nastavnim planom i programom škole predviđeno za izvođenje sadržaja iz rukometa.

Svaki od 16 nastavnih sati imao je tri dijela: 1) uvodno-pripremi, 2) glavni i 3) završni. Prvi dio trajao je 8 minuta i u njemu je provedeno zagrijavanje. Najprije je primijenjena trominutna ciklična aktivnost (najčešće trčanje i preskakanje vijalice), a zatim vježbe oblikovanja u trajanju od 5 minuta. Glavni dio sata trajao je 32 minute i uključivao je osnovnu obuku i uvježbavanje elemenata rukometa. Sadržaji su kreirani prema uputama iz stručne literature (Rogulj, 2021). Kada su učenici nakon prva 4 tjedna u dovoljnoj mjeri svladali osnovne elemente, na svakom satu organizirana je igra na dva gola, najčešće u obliku minirukometa (Green, 2024; Hjorth, 2024) i

trajala je 6 - 8 minuta. Završni dio trajao je 5 minuta i uključivao je vježbe istezanja i relaksacije. Na svim nastavnim satima u obje skupine korišteni su identični sadržaji. Jedina je razlika bila u onome što je toj nastavi prethodilo. Dok ispitanici kontrolne (TTO) skupine nisu imali prethodnu pripremu za nastavu, ispitanici eksperimentalne (OU) skupine dolazili su na sat s određenim informacijama o elementima rukometa dobivenim unaprijed.

Nastavnik je putem mobitela, korištenjem Whatsapp aplikacije, dva dana prije nastave slao videomaterijal učenicima eksperimentalne skupine. Ovi videoisječci (u trajanju od 4 do 5 minuta) objašnjavali su osnovne elemente tehnike koja će se obrađivati na sljedećem satu i prikazivali planirane vježbe. Većinu isječaka pripremio je osobno nastavnik uz pomoć starijih učenika koji su članovi školske rukometne sekcije, dok su neki isječci preuzeti s YouTubea (primjerice isječci iz Hummelove male škole rukometa <https://www.youtube.com/watch?v=abVjf-3Z0NI>; <https://www.youtube.com/watch?v=s8gd-EE76Qw>). Osim toga, na kraju sata TO-a ispitanici eksperimentalne skupine zajednički su analizirali izvedbu rukometnih elemenata pregledavajući snimke sa svojih mobitela uočavajući eventualne pogreške.

Jesu li ispitanici eksperimentalne skupine pregledavali i u kojoj su mjeri razumjeli informacije iz unaprijed poslanih isječaka, nastavnik je provjeravao neposredno prije početka svakog sata, prvo pregledom Whatsapp, a zatim kratkom provjerom znanja učenika. Kako bi učenici ozbiljno shvatili važnost učenja unaprijed, nastavnik je prije svakog sata provjeravao poznavanje informacija iz videomaterijala tako što im je nasumično postavio nekoliko kratkih pitanja vezanih uz osnove izvođenja rukometnih elemenata (npr. „Kakav je položaj ruke pri izbačaju lopte?“; „Kako izgleda pravilan obrambeni stav?“; „Kako se lopta nakon hvatanja dovodi u poziciju za izbačaj?“; „Kako se izvodi skok šut?“; „Što je i kada se izvodi „šase“?“ itd.).

Učinci eksperimentalnih postupaka (intervencija) procijenjeni su na temelju podataka o sljedećim varijablama: (1) motorička kompetencija (ocjene učenika dobivene za elemente rukometa), (2) stavovi učenika prema nekim aspektima TO-a (zadovoljstvo, lagodnost, aktivitet i nastavnik) i (3) obujam vježbanja učenika na satu (vrijeme aktivnoga vježbanja). Procjena kvalitete izvedbe rukometnih elemenata provedena je u skladu s teorijskim biomehaničkim principima koji objašnjavaju racionalnu rukometnu tehniku (Karišik i sur., 2012; Rogulj, 2021). Ispitanici su svoje stavove prema TO-u iskazali prije i poslije eksperimenta ispunjavanjem standardiziranoga upitnika. Vrijeme aktivnoga vježbanja mjereno je na po 4 sata u obje skupine. Svi postupci provedeni su u skladu s odredbama Helsinške deklaracije o radu s ljudima (WMA, 2018.). Eksperiment je realiziran u sklopu doktorske disertacije koju je odobrio Senat Sveučilišta Crne Gore (odluka br. 01-330/10 od 11. 7. 2024. godine).

Uzorak

Istraživanje je provedeno na grupnom uzorku. Početni uzorak uključivao je 54 ispitanika (po 27 učenika iz dvaju razrednih odjela šestoga razreda osnovne škole).

Ispitanici su bili stari 11 godina (± 6 mjeseci), a među njima su podjednako zastupljeni učenici obaju spolova. U jednom razredu (eksperimentalna skupina) primijenjena je obrnuta učionica (PU), a u drugom (kontrolna skupina) tradicionalni model organiziranja nastave tjelesnoga odgoja (TTO). Glavni uvjet za ulazak u konačni uzorak jest da su učenici obiju skupina vježbali najmanje na 80 % sati rukometa (13 od 16 realiziranih) tijekom eksperimentalnoga perioda. Iz uzorka su izostavljeni i učenici koji treniraju rukomet u lokalnom klubu (četiri učenika – dvojica dječaka i dvije djevojčice). Ovi učenici-sportaši nisu isključeni iz nastave, već su redovito vježbali i bili podrška nastavniku pri demonstriranju pojedinih elemenata. Na temelju ovih kriterija (minimalno 13 sati vježbanja i bez dodatnih sati rukometnoga treninga) u konačni uzorak ušlo je ukupno 40 ispitanika s potpunim podacima, od čega 21 u eksperimentalnoj (OU) i 19 u kontrolnoj (TTO) skupini.

Instrumenti i postupci

Ocjenjivanje rukometnih elemenata

Za potrebe ovoga istraživanja prikupljeni su podatci (ocjene) o elementima rukometa koji su predviđeni nastavnim planom i programom TO-a u osnovnoj školi. Ocjenjivano je sljedećih šest elemenata: 1) hvatanje, 2) dodavanje, 3) vođenje lopte, 4) obrambeni stav, 5) bočni šut (šase) i 6) skok šut u dalj. Svi elementi ocijenjeni su prije (predtest) i nakon eksperimenta (posttest). Pravilna izvedba svih elemenata detaljno je opisana u stručnoj literaturi (Karišik i sur., 2013; Rogulj, 2021).

Rukometne elemente ocjenjivala su dva neovisna stručnjaka (rukometni treneri) uz asistenciju nastavnika TO-a (prvi autor). Izvedba elemenata valorizirana je broјčanom ocjenom na ljestvici od 1 do 5, pri čemu je pet najviša, a jedna najniža. Konačna ocjena dobivena je usuglašavanjem mišljenja ocjenjivača.

Ocjene rukometnih elemenata imaju sljedeće značenje:

Ocjena 1 – ispitanik ne može uspješno izvesti zadani element

Ocjena 2 – ispitanik zadani element izvodi isprekidano i s mnogo pogrešaka

Ocjena 3 – ispitanik dobro izvodi zadani element, ali ga ne može ponoviti više od tri puta bez pogreške

Ocjena 4 – ispitanik zadani element izvodi koordinirano kada ga nitko ne ometa, ali griješi kada ubrza kretanje ili kada element izvodi u igri

Ocjena 5 – ispitanik zadani element izvodi koordinirano u većim brzinama, kao i tijekom igre, uz minimalne tehničke pogreške.

Obrambeni stav bio je jedini element koji se izvodio bez lopte, pa je pri njegovoj valorizaciji primijenjen specifičan pristup. Ocjenjivači su prije svega promatrali sposobnost ispitanika da održi zadani kut koljenskoga zgloba u vježbama koje se izvode u mjestu i kretanju. Značajnu pozornost posvetili su i učinkovitosti igranja obrane tijekom maloga rukometa. Oni su pažljivo raspravljali o svakoj ocjeni, a formirali su je konsenzusom.

Procjena stavova prema tjelesnom odgoju

Za procjenu stavova prema TO-u korišten je instrument PEAS (*Physical Education Attitude Scale*) koji su konstruirali i standardizirali na školskoj populaciji Orlić i sur. (2017). Autori i 50 studenata diplomskog studija Fakulteta sporta i tjelesnog odgoja izradili su 124 početna zadatka tijekom stručne prakse. Nakon eliminacije dvosmislenih stavki, provedena je faktorska analiza i u konačnoj verziji upitnika izdvojene su četiri stabilne komponente koje objašnjavaju 48 % ukupne varijance, a imenovane su na sljedeći način: (1) zadovoljstvo (12 stavki), (2) lakoća (12 stavki), (3) aktivnost (11 stavki) i (4) učitelj (8 stavki). Stav prema svakoj od 43 tvrdnje izražava se Likertovom ljestvicom do pet stupnjeva, a odgovori se daju što je moguće brže. Odgovori su formulirani na sljedeći način: (1) uopće se ne slažem, (2) ne slažem se, (3) neodlučan sam, (4) slažem se i (5) potpuno se slažem. Najafirmativniji odgovor dobiva ocjenu pet, a najnepovoljniji odgovor ocjenu jedan. Neke su stavke formulirane pozitivno, a neke negativno, pa je prije izračuna konačne ocjene bilo potrebno izvršiti inverziju (prekodiranje) za negativne tvrdnje. Prekodiranje je provedeno na sljedeći način: 1→5, 2→4, 4→2 i 5→1. Konačni rezultat za svaku od četiri PEAS komponente je prosjek izračunat iz odgovarajućih stavki.

Iako je ovaj instrument standardiziran na populaciji 13-godišnjih učenika, ovdje je primijenjen na nešto mlađoj djeci. Ovo je jedno od ograničenja studije kojeg su autori bili svjesni, ali su željeli vidjeti kako je PEAS primjenjiv u istraživanju s 11-godišnjacima. U nekom budućem istraživanju bilo bi dobro provjeriti metriku ovoga instrumenta, ali na znatno većem uzorku učenika petih i šestih razreda.

Mjerenje aktivnoga vremena na satu Tjelesnog odgoja

Podaci o aktivnom vremenu vježbanja na satu TO registrirani su instrumentom SOFIT (*System for Observing Fitness Instruction Time*) koji su konstruirali McKenzie i sur. (1991). Često je korišten u prethodnim istraživanjima (McKenzie i Smith, 2017; McNamee i van der Mars, 2005; Powel i sur., 2016; Smith i sur., 2019). Izvorno je zamišljen kao dijagnostički instrument namijenjen nastavnicima za kontrolu opterećenja na satu, a kasnije je modificiran i prilagođen za istraživačke potrebe. U ovoj studiji korištena je posljednja verzija instrumenta opisana u priručniku dostupnom na internetu (McKenzie, 2017). Aktivno vrijeme mjereno je samo u glavnom dijelu sata, a provodila su ga tri učenika koji nisu vježbali. Svaki od njih je mobitelom snimao jednoga ispitanika tijekom glavnoga dijela sata, a zatim izdvajao relevantne podatke i unosio ih u promatrački list. Aktivni učenici nisu znali tko ih snima. Aktivno vrijeme mjereno je na četiri sata TO koje je nastavnik nasumično odabrao. Za konačni izračun aktivnoga vremena korišteni su podatci svih učenika i iz njih je izveden prosjek. Ti su prosjeci tretirani kao pokazatelji angažmana cijele grupe na satu tjelesnoga odgoja.

Promatrački list za unos podataka predviđa 8 četverominutnih segmenata podijeljenih u nekoliko intervala od po 20 sekundi (3 intervala po minuti). Tijekom 4 minute promatranja zabilježeni su podatci za 12 intervala, odnosno ukupno 96 intervala za

cijeli glavni dio sata koji traje 32 minute. Za unos podataka o aktivnostima s različitim utroškom energije korištene su posebni kodovi: kod 1 označava ležanje, kod 2 sjedenje, kod 3 stajanje, kod 4 hodanje i kod 5 svako kretanje pri kojem učenik troši više energije nego za prosječno hodanje (npr. trčanje, skok, dodavanje i hvatanje, vođenje lopte, šut na gol itd.). Podatci su se unosili zaokruživanjem odgovarajućega koda (1, 2, 3, 4 ili 5), što je olakšavalo i ubrzavalo bilježenje. Aktivno vrijeme iskazano je na dva načina – kao relativna vrijednost (postotci) i kao apsolutno vrijeme (minute).

Statistička analiza

Za svaku varijablu izračunati su osnovni deskriptivni parametri - aritmetička sredina (Mean) i standardna devijacija (SD).

Za procjenu učinaka eksperimentalnoga postupka i provjeru homogenosti skupina prije početka eksperimenta korištena je kombinirana analiza varijance koja se u literaturi naziva Mixed between-within subjects ANOVA (Tabachnick i Fidell, 2013). Kombinirana su dva faktora (dvije neovisne varijable): vrijeme (unutarskupni varijabilitet) i specifičnost dviju skupina (međuskupni varijabilitet). Primjenjen je 2 x 2 kombinirani nacrt za usporedbu podataka dviju skupina iz različitih vremenskih točaka (predtest i posttest). Stvarni utjecaj neovisnih varijabli (postupak i grupa), kako zajednički (interakcija faktora) tako i separadni, procijenjen je pomoću parcijalnog eta kvadrata (η^2), na temelju kriterija koje je predložio Cohen (1988). Ovaj postupak primijenjen je na ocjene šest rukometnih elementa i na podatke o stavovima prema TO koji su dobiveni prije i nakon eksperimenta.

Za procjenu značajnosti razlika između aritmetičkih sredina dobivenih za aktivno vrijeme vježbanja na satu TO-a u eksperimentalnoj i kontrolnoj skupini, primijenjen je T-test za neovisne uzorke (*Independent Sample t-test*). Prije tumačenja rezultata oba postupka (ANOVA i T-test), primjenom Levinovoa testa (*Levene's test*), provjerena je pretpostavka o homogenosti varijanci (Pallant, 2020).

Kompletna statistička analiza provedena je pomoću aplikacijskoga statističkog programa IBM SPSS v.21 (License Stats Prem: 761b17dcfd1bf20da576 by Hearne software). Svi zaključci su provedeni na razini značajnosti od 0,05 ($p < 0,05$).

Rezultati

Deskriptivni podatci o elementima rukometa koji su ocjenjeni prije i nakon eksperimenta prikazani su u Tablici 1 i pokazuju da su skupine prije primjene tretmana bile vrlo homogene u pogledu početnih rukometnih vještina. Rezultati kombinirane analize varijance otkrivaju da je samo eksperimentalni postupak značajno utjecao na promjene prosječnih ocjena za sva četiri elementa, dok je utjecaj skupina potpuno izostao (Tablica 2). Utjecaj interakcije faktora utvrđen je samo za četiri elementa - hvatanje, dodavanje, bočni šut i skok šut u dalj. U preostala dva rukometna elementa, vođenje lopte i obrambeni stav, nije bilo značajnoga utjecaja interakcije faktora, što znači da se grupe nisu značajno razlikovale u tim elementima na kraju eksperimenta.

Praktično, obje su skupine (OU i TTO) značajno poboljšale vođenje lopte i obrambeni stav, a oba eksperimentalna postupka bila su približno jednako učinkovita. Ovi nalazi pokazuju da su obje skupine značajno unaprijedile sve elemente rukometa pod utjecajem vježbanja, ali da su promjene kvaliteta dodavanja, hvatanja i šutiranja značajno veće u eksperimentalnoj skupini u kojoj je primijenjena metoda obrnute učionice.

Tablica 1

Tablica 2

Slika 1.

Deskriptivni podatci o stavovima prema TO-u koje su ispitanici iskazali prije i nakon eksperimenta prikazani su u Tablici 3 i ilustrirani Slikom 2. Oni pokazuju da su skupine prije primjene postupka bile vrlo homogene u odnosu na sve četiri podskale (zadovoljstvo, lagodnost, aktivitet i nastavnik). Rezultati kombinirane analize varijance (Tablica 5) otkrivaju da su i interakcija faktora i zaseban utjecaj eksperimentalnoga postupka bili statistički značajni kod sve četiri podskale, dok je zaseban utjecaj skupina potpuno izostao. Ovi nalazi pokazuju da su kineziološke intervencije u obje skupine dovele do značajnih pozitivnih promjena stavova prema TO-u, ali da su one više izražene u eksperimentalnoj (OU) skupini.

Tablica 3

Tablica 4

Slika 2.

Podatci dobiveni mjerenjem aktivnoga vremena vježbanja u glavnom dijelu sata prikazani su u Tablici 5 i ilustrirani Slikom 3. Rezultati otkrivaju da su učenici eksperimentalne (PU) grupe značajno više vremena proveli u aktivnostima većega intenziteta, a značajno su manje stajali i hodali. Grupe se nisu značajno razlikovale samo u sjedenju.

Tablica 5

Slika 3.

Rasprava

U ovom istraživanju analizirani su učinci suvremene metode organiziranja nastave tjelesnoga odgoja (TO) koja se posljednjih godina sve više primjenjuje u školama diljem svijeta. To je obrnuta učionica (OU) koja podrazumijeva dijeljenje osnovnih teorijskih i vizualnih informacija o sadržaju narednoga sata TO-a unaprijed pomoću mobilnih tehnologija (prije svega mobitela). Ova metoda značajno mijenja tradicionalan način pripreme za sat i nastavnika i učenika. U tradicionalnoj nastavi tjelesnoga odgoja (TTO) nastavnik mnogo vremena troši na davanje osnovnih informacija o aktivnostima koje se obrađuju na satu, dok se dijeljenjem informacija prije sata stvara više prostora za

praktičan rad (učenje i uvježbavanje). Rezultati nekoliko prethodnih studija dokazuju prednosti OU-a nad TTO-om tijekom realizacije različitih nastavnih sadržaja. Pozitivni učinci metode OU najviše su vidljivi kroz unaprjeđenje motoričke kompetentnosti, motivacije za vježbanje i stavova prema TO-u (Østerlie i Kjelaas, 2019; Østerlie i Mehus, 2020). Veći motorički napredak utvrđen je za rukomet (Felgueras i Delgado, 2021), odbojku (Feriz-Valero i sur., 2022), stolni tenis (Zhao i Kang, 2020) i *korboll* (Markues-Molias i sur. 2019). U ovom istraživanju praćen je utjecaj OU-a na elemente rukometa koje su učila i uvježbavala djeca stara 11 godina. Rukomet je odabran zato što se nalazi u nastavnom planu i programu redovne nastave TO-a u osnovnim školama i realizira se s učenicima šestoga razreda kojima je prvi autor bio nastavnik.

Rezultati ove studije potvrdili su sve nalaze prethodnih studija. Pokazalo se da je rukomet pogodna aktivnost za primjenu metode OU-a. Eksperimentalna skupina imala je značajno veći napredak od kontrolne nakon intervencija u četiri od šest praćenih rukometnih elemenata. Obrnuta učionica donijela je prednost prvenstveno pri učenju i uvježbavanju dodavanja i hvatanja te šutiranja na gol. Prednosti ove metode pripreme sata TO-a izostale su u elementima s najslabijim ocjenama, koji su učenicima očito bili teži – vođenje lopte i kretanje u obrambenom stavu. Ovaj nalaz navodi na zaključak da učinkovitost OU metode ovisi o težini motoričkoga zadatka koji se uči. Obrnuta učionica očito je manje učinkovita što je motorički zadatak teži. OU metoda bila je najučinkovitija u lakšim motoričkim zadacima, odnosno onim za koje su učenici dobili najbolje ocjene. To su elementi vezani uz temeljne rukometne vještine čija je složenost usklađena s razvojnim stupnjem i motoričkim sposobnostima djece ove dobi.

Ostaje otvoreno pitanje zašto su ispitanici obje skupine dobili slabije ocjene za vođenje lopte i obrambeni stav? Je li dribling, pogotovo u pokretu, toliko zahtjevan za učenike šestoga razreda da im je i nakon dva mjeseca nastave prosjek ocjena manji od tri? Izostanak viših prosječnih ocjena vjerojatno je posljedica činjenice da se ovaj element najmanje koristi u rukometnoj igri i da je na njega utrošeno najmanje vremena u nastavi. To pokazuje da je, unatoč jasnim objašnjenjima i vizualnim uputama koje učenici dobivaju unaprijed, neposredna vježba (tjelesna aktivnost) ključna za motoričko učenje. Obrnuta učionica sama po sebi ne garantira uspjeh ako nema praktičnih aktivnosti (obučavanja, pokušavanja, uvježbavanja i sl.). S druge strane, za vježbanje obrambenoga stava potrošeno je mnogo vremena i organizirano više vježbi, ali je prosječna ocjena u kontrolnoj skupini i nakon tih postupaka ostala manja od trojke, a u eksperimentalnoj bila točno tri. Jedno od mogućih objašnjenja jest činjenica da kvaliteta kretanja u obrambenom stavu uvelike ovisi o snazi mišića opružaća nogu (Karišik i sur., 2013.), koji su vjerojatno nedovoljno razvijeni kod ispitanika ove dobi. U svakom slučaju, učinkovitost i napredak obrambenoga stava bilo je teže objasniti u usporedbi s ostalim elementima rukometa s loptom. Uočeno je da su, unatoč dobrom izvođenju obrambenoga stava u vježbama za učenje, neki ispitanici loše igrali obranu u minirukometu. I obrnuto - pojedini ispitanici bili su vrlo uspješni u obrani tijekom minirukometa, ali su prema ocjeni ocjenjivača imali slabiju tehničku izvedbu. Čini

se da na kvalitetu obrane u rukometu, osim tehnike obrambenoga stava, utječu i mnogi drugi čimbenici koji nisu evaluirani u ovom istraživanju (npr. snaga, brzina, koordinacija, agilnost, taktičke sposobnosti itd.).

OU metoda dala je najbolje rezultate u elementima koji se najviše koriste u rukometnoj igri i za koje je tijekom nastave potrošeno najviše vremena – dodavanje, hvatanje i šutiranje. Njihove prosječne ocjene u obje skupine bile su značajno veće na posttestu nego na predtestu, ali s mnogo većim promjenama u eksperimentalnoj skupini. Njihova složenost očito je u skladu sa aktualnim motornim razvojem učenika šestoga razreda i ti elementi vjerojatno ne ovise mnogo o snazi aktualne muskulature. Ovu pretpostavku podupiru nalazi prethodnih studija koje dokazuju da je za kvalitetu bacanja rukometne lopte presudna tehnika, a ne snaga (Arias, 2012; Manchado i sur., 2017; Perić i sur., 2015; Rivilla-Garsia i sur., 2011).

Na učinkovitiji razvoj motoričke kompetentnosti vjerojatno je utjecalo i dulje aktivno vrijeme vježbanja na nastavi eksperimentalne skupine. Njihovo aktivno vrijeme u glavnom dijelu sata bilo je oko 7,5 % duže od učenika kontrolne skupine. Na prvi pogled to nije mnogo, pogotovo kada se izrazi u minutama, ali je ipak statistički značajno. Učenici koji su prije nastave dobili didaktičke videomaterijale i pomoću mobitela se unaprijed upoznali s osnovnim informacijama o rukometnim elementima bili su, u prosjeku, dvije i pol minute aktivniji od učenika koji su imali tradicionalnu nastavu TO-a. OU metoda omogućila je eksperimentalnoj skupini da dosegne 50 % vremena aktivnoga vježbanja na satu, što je u prethodnim studijama preporučeno kao nužni minimum za ispunjenje osnovnih ciljeva školskoga TO-a (Hallal i sur., 2012; Hollis i sur., 2016; WHO, 2014). S druge strane, prosječno vrijeme aktivnoga vježbanja kontrolne skupine nije doseglo ni 43 %. O većoj aktivnosti eksperimentalne skupine govore i podatci o vremenu stajanja, za koje je također utvrđena statistički značajna razlika na štetu kontrolne skupine. Učenici koji nisu imali teorijsku pripremu prije nastave u prosjeku su 1/4 glavnoga dijela sata proveli stojeći, najvjerojatnije slušajući nastavnikova objašnjenja o pravilnom izvođenju elementa ili o ispravljanju pogrešaka. Ovi podatci potvrđuju nalaze prethodnih studija (Campos-Gutiérrez i sur., 2021; Ferriz-Valero i sur., 2021; Zhu i sur., 2023) koje su također dokazale da teorijske i vizualne informacije dobivene unaprijed mogu utjecati na povećanje aktivnoga vremena vježbanja. U ovom istraživanju registrirano je značajno dulje aktivno vrijeme na satu TO-a nego u prethodnim studijama u kojima su također korištene igre loptom (košarka, odbojka i rukomet). Marković i sur. (2012.) izvještavaju da je prosječna iskorištenost tih sati 41 %, a Kostić i sur. (2020) 42 %, te navode da to najviše ovisi o pripremi nastave.

Rezultati ovoga istraživanja nedvosmisleno ukazuju na značajan utjecaj OU metode na poboljšanje stavova učenika prema TO-u. Ispitanici obje skupine iskazali su umjereno pozitivan stav prema svim aspektima TO-a i prije eksperimentalnoga postupka. Ove prosječne vrijednosti nakon eksperimenta dodatno su se povećale, ali statistički značajne promjene registrirane su samo u skupini koja je radila po metodi obrnute učionice. Prije intervencija stavovi ispitanika različitih skupina nisu se značajno razlikovali ni

u jednoj podskali, dok su osam tjedana kasnije ispitanici eksperimentalne skupine imali signifikantno veće prosječne vrijednosti svih podskala (zadovoljstvo, lagodnost, aktivitet i nastavnik). Nakon završetka eksperimenta ocjene za lagodnost i nastavnika bile su čak veće od 4. Ovi rezultati dokazuju da se postignuti učinci mogu pripisati eksperimentalnoj metodi pripremanja nastave. Obrnuta učionica je, po svemu sudeći, omogućila učenicima više vremena za aktivno vježbanje, smanjila vrijeme provedeno u pasivnim položajima (stajanju i hodanju) te obogatila komunikaciju između nastavnika i učenika. Ova zapažanja su u skladu s rezultatima prethodnih studija koje su također ispitivale aktivnost nastavnika na satu (Hinojo sur., 2020; Østerlie i Kjelaas, 2019; Østerlie i Mehus, 2020) i stavove učenika prema TO-u (Bailey, 2006; Portman, 2003; Prochaska, i sur., 2003; Subramaniam i Silverman, 2007). Sve spomenute studije dokazale su pozitivnu vezu između metode obrnute učionice s jedne te angažiranja nastavnika i stavova učenika s druge strane.

Osim za dobivanje informacija o rukometnim elementima, mobiteli su korišteni i za mjerenja vremena aktivnoga vježbanja na nastavi. To je bio zadatak učenika koji su bili prisutni na nastavi, ali nisu vježbali. Kasnije su na temelju snimljenoga materijala ispunjavali SOFIT promatrački list i zajedno sa svojim kolegama analizirali izvedbu rukometnih elemenata. Na taj način neaktivni učenici koji su potpuno pasivni i obično se dosađuju na satu, postaju aktivni sudionici nastavnoga procesa, povećavaju svoju znatiželju i stječu barem teorijska znanja o pojedinim sportskim sadržajima. Produbljena komunikacija na relaciji učenik-nastavnik i učenik-učenik tijekom zajedničke analize snimljenih aktivnosti, približava nastavni proces onome što se u suvremenoj pedagogiji naziva duboko učenje i predstavlja najviši oblik aktivnoga znanja (Fallah i sur., 2022; Ferriz-Valero i sur., 2022). Metoda OU-a potakla je duboko učenje s obzirom na to da su učenici slojevito dobivali informacije o rukometnim elementima i mentalno ih procesirali ne samo dok su vježbali na satu, već i prije i nakon toga. Oni su najprije samostalno pokušali razumjeti osnovne teorijske (biomehaničke) poruke o motoričkim sadržajima koji ih očekuju, zatim su na satu to praktično izvodili sa svojim kolegama, a s analizama su nastavili i nakon sata pregledom videomaterijala i diskusiju s ostalim učenicima i nastavnikom. Time je postignuta višeslojnost u komunikaciji između neuronskih cjelina i proširen kontekst u kojem se kognitivno obrađivao edukativni materijal.

Osim učenicima, obrnuta učionica donosi dobrobit i nastavnicima, približavajući ih TRACK modelu (*Technological Pedagogical Content Knowledge*) koji se intenzivno primjenjuje u suvremenoj školi upućujući profesora tjelesnoga odgoja na ovladavanje potrebnim znanjima i vještinama za uspješno integriranje mobilne tehnologije u nastavni proces. Ovaj se model najčešće prikazuje Venovim dijagramom čiji presjek predstavlja minimalnu sumu kompetencija suvremenoga nastavnika (Archambault i Barnett, 2010). To su kompetencije iz područja tehnologije, specifične struke (u ovom slučaju kineziologije), pedagoško-didaktičke i metodičke kompetencije te sposobnost primjene mješovitih modela (npr. flipped classrooms). Iskustva istraživača pokazuju

da je digitalno kompetentniji učitelj spremniji za primjenu suvremenih didaktičkih metoda jer njegove veće kompetencije povećavaju motivaciju za uvođenje novih modela poučavanja (Balanskat, 2013; Pegrum i sur., 2013). Specijalizacija u korištenju digitalnih alata podrazumijeva izgradnju nastavnoga okružja usmjerenoga na ciljeve tjelesnoga odgoja, upoznavanje komplementarnih područja i primjenu holističkoga pristupa pedagoškim zadaćama.

Iako su empirijski podatci pokazali da OU metoda može donijeti brojne prednosti suvremenoj nastavi TO-a, važno je istaknuti i nekoliko ograničenja ove studije. Ona su prvenstveno vezana za neprobabilistički način uzorkovanja i mali broj ispitanika obuhvaćenih analizama. Za eksperiment i prikupljanje podataka korišten je kontrolirani skupni uzorak, odnosno samo dva razreda jedne škole. Iako se nastojalo osigurati neovisnost ispitanika dviju skupina, učenicima koji su činili kontrolnu skupinu bilo je teško sakriti da njihove kolege iz iste škole i iste smjene, od kojih je formirana eksperimentalna skupina, sudjeluju u znanstvenom istraživanju. Ta spoznaja mogla je kod ispitanika kontrolne skupine izazvati placebo efekt i neizravno utjecati na promjene u mnogim varijablama, neovisno o objektivnom (ne)djelovanju eksperimentalnog postupka.

Drugo ograničenje koje upućuje na oprez pri generalizaciji dobivenih rezultata odnosi se na izbor nastavnih sadržaja. U ovom istraživanju primijenjeni su samo elementi rukometa, pa bi bilo korisno u budućim istraživanjima provjeriti kako obrnuta učionica funkcionira u drugim sportovima (atletici, gimnastici, plivanju, košarci itd.). Osim toga, bilo bi dobro izmjeriti neke motoričke sposobnosti učenika i tretirati ih kao statističke kovarijate koje posredno mogu utjecati na brzinu i kvalitetu motoričkoga učenja. Primjerice, pri kretanju u obrambenom stavu nisu dobivene značajne razlike između ispitanika eksperimentalne i kontrolne skupine, pa je kao hipotetično objašnjenje navedena nedovoljna snaga mišića opružaća nogu.

Zaključak

S dva razredna odjela šestoga razreda osnovne škole proveden je eksperiment u kojem su uspoređeni učinci dviju metoda pripreme nastave tjelesnoga odgoja. Učenici su učili i uvježbavali elemente rukometa. Prva metoda bila je obrnuta učionica dok je druga podrazumijevala tradicionalnu realizaciju tjelesnoga odgoja. U sklopu obrnute učionice učenicima je putem mobitela unaprijed distribuiran videomaterijal s teorijskim i vizualnim informacijama o sadržajima koji se obrađuju na satu tjelesnoga odgoja. Eksperiment je trajao dva mjeseca (8 tjedana) i provedeno je 16 školskih sati u trajanju od 45 minuta. Osim sportskoga postignuća, koje je vrednovano na osnovi ocjena dobivenih za izvođenje rukometnih elemenata, procijenjeni su stavovi učenika prema tjelesnom odgoju i izmjereno aktivno vrijeme vježbanja u glavnom djelu sata.

Dobiveni rezultati potvrdili su vrijednosti metode obrnute učionice konstatirane u prethodnim studijama. Dokazano je da je ovaj način rada učinkovitiji od tradicionalne nastave. Ispitanici eksperimentalne skupine postigli su statistički veći napredak u četiri od šest rukometnih elemenata (dodavanju, hvatanju i šutiranja na gol).

Ispitanici obiju skupina iskazali su umjereno pozitivan stav prema tjelesnom odgoju prije eksperimenta i nisu se značajno razlikovali, dok su nakon postupka ispitanici eksperimentalne imali značajno pozitivnije stavove od ispitanika kontrolne skupine. Eksperimentalna skupina imala je dulje vrijeme aktivnoga vježbanja u glavnom dijelu sata. U ovoj skupini dostignuta je razina od 50 % angažiranosti učenika što je više od vremena izmjerenih u prethodnim studijama u kojima su također korištene sportske igre loptom. Dobiveni rezultati pokazuju da metoda obrnute učionice može dati značajan doprinos unaprjeđenju nastave tjelesnoga odgoja u osnovnim školama.

Pokazalo se da učinci metode obrnute učionice ovise o složenosti motoričkih zadataka koji se obrađuju na satu. Kod težih elemenata (vođenje lopte i obrambeni stav) ova metoda nije dala didaktičku prednost u odnosu na tradicionalnu nastavu. Najveći učinci obrnute učionice postignuti su u zadacima srednje težine koji su usklađeni s razvojnom razinom motoričkih sposobnosti ispitanika (u ovoj studiji to su dodavanje i hvatanje te dva načina šutiranja). Metoda obrnute učionice imala je snažan utjecaj i na stavove prema tjelesnom odgoju. Dokazano je da obrnuta učionica značajno pridonosi učinkovitijem iskorištavanju vremena u nastavi tjelesnoga odgoja, a da kontrolirana uporaba mobitela koristi nastavnom procesu i poboljšava komunikaciju svih njegovih sudionika.